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Attorney Docket No.: 27996-092

OIPE IAP8
JUN 29 2006
PATENT & TRADEMARK OFFICE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicants:	Jianglei Ma et. al.	Art Unit:	2667
Serial No.:	09/751,881	Examiner:	Jones, Prenell P.
Filing Date:	December 29, 2000	Attorney Docket No.	27996-092
Confirmation No.	8544		
For:	SYNCHRONIZATION IN A MULTIPLE-INPUT/MULTIPLE-OUTPUT (MIMO) ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING (OFDM) SYSTEM FOR WIRELESS APPLICATIONS		

Certificates of Correction Branch
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Certificate
JUL 06 2006
of Correction

TRANSMITTAL LETTER

Transmitted herewith for filing in the present patent are the following documents:

1. Request for Certificate of Correction for Letter Patent, (7 pages);
2. Certificate of Correction, in duplicate (8 pages);
3. Copy of a Amendment After Notice of Allowance Under 37 §1.312 filed on November 23, 2004; (21 pages);
4. Check # 3292 in the amount of $100.00; and
5. Return Postcard.

If the enclosed papers are considered incomplete, the Mail Room is respectfully requested to contact the undersigned collect at (212) 935-3000, New York, New York.

The Commissioner is hereby authorized to charge any additional fees due, or credit any overpayment of same, to Deposit Account No. **50-0311**; Reference No. **27996-092**; Customer No. **35437**. A duplicate copy of this Transmittal Letter is provided for this purpose.

JUL 07 2006

Dated: June 28, 2006

Respectfully submitted,

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

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Certificates of Correction Branch
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

REQUEST FOR CERTIFICATE OF CORRECTION UNDER 37 C.F.R. 1.322 AND 37 C.F.R. 1.323

Sir:

The patentee of the above-identified patent, through their attorney, hereby request issuance of a Certificate of Correction.

The following errors are considered to be the fault of the Patent Office. The correction is not believed to involved such change as would constitute new matter or require examination. No fee is required to correct these errors.

The correction is required in the "Detailed Description of the Invention", as follows:

Column 7, line 57: insert --$l \in [-N_{\max}, N_{\min}], and$ --

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The correction is required in the Claims, as follows:

Claim 1, Column 8, line 42: delete "synchronization"

insert --synchronizing--

Claim 1, Column 8, line 47: insert --received signal; and-- after words "correlator algorithm to said"

Claim 1, Column 8, line 48: delete "received signal; and"

Claim 2, Column 8, line 56: delete "$\rho/2$"

Claim 2, Column 8, line 59: insert --$\rho/2$-- in front of the words "$\sum_{l=0}^{N_{symbol}-1}$"

Claim 2, Column 8, line 65: delete "X_{coarse}^{i}"

insert --x_{coarse}^{i}--

Claim 3, Column 9, line 34: delete "X_{fine}"

insert --x_{fine}--

Claim 3, Column 9, line 35: delete "$X \in [X_{coarse} - N_{fine}, X_{coarse} + N_{fine}];$"

insert -- $x \in [x_{coarse} - N_{fine}, x_{coarse} + N_{fine}];$ --

Claim 14, Column 11, line 5: delete "$\rho / 2$"

Claim 14, Column 11, line 8: insert -- $\rho / 2$ -- in front of the words "$\sum_{l=0}^{N_{symbol}-1}$"

Claim 14, Column 11, line 15: delete "$X_{coarse}^{\ i}$"

insert -- $x_{coarse}^{\ i}$ --

Claim 15, Column 11, line 49: delete "X_{fine}"

insert -- x_{fine} --

Claim 15, Column 11, line 50: delete "$X \in [X_{coarse} - N_{fine}, X_{coarse} + N_{fine}];$"

insert -- $x \in [x_{coarse} - N_{fine}, x_{coarse} + N_{fine}];$ --

Claim 18, Column 12, line 21: delete "PN_l^*"

insert -- PN_i^* --

Claim 24, Column 13, line 18: delete "X_{coarse}^{i}"

insert --x_{coarse}^{i}--

Claim 25, Column 13, line 51: delete "X_{fine}"

insert --x_{fine}--

Claim 25, Column 13, line 52: delete "$X \in [X_{coarse} - N_{fine}, X_{coarse} + N_{fine}];$"

insert --$x \in [x_{coarse} - N_{fine}, x_{coarse} + N_{fine}];$--

Claim 28, Column 14, line 27: delete "$R_{train \int_{\square}^{\square} d\square}$"

insert --R_{train}--

The following errors are considered to be the fault of the Applicant. The correction is not believed to involve a change that would constitute new matter or require examination. The Applicant encloses an appropriate fee under 37 C.F.R. 1.20(a).

The correction is required in the "Summary of the Invention", as follows:

Column 2, line 33: delete "synchronization"

insert --synchronizing--

Column 3, line 10: delete "course"

insert --coarse--

The correction is required in the "Detailed Description of the Invention", as follows:

Column 7, line 57: delete "$l \in [-N_{\max}, N_{\min}], and$"

insert --$k \in [-N_{\max}, N_{\min}], and$--

Column 7, line 54: delete "$k \min$"

insert --$k_{\min}$--

The correction is required in the Claims, as follows:

Claim 2, Column 8, line 67: delete "r^{*}_{t}"

insert --$r_t^{i^*}$--

Claim 8, Column 10, line 23: delete "$l \in [-N_{\max}, N_{\max}];$"

insert --$k \in [-N_{\max}, N_{\max}];$--

Claim 8, Column 10, line 26:	delete "frequency the" insert --the frequency--
Claim 8, Column 10, line 14:	delete "index is determined" insert --index Z is determined
Claim 8, Column 10, line 28:	delete "K_{min}" insert --k_{min}--
Claim 13, Column 10, line 53:	delete "synchronization" insert --synchronizing--
Claim 14, Column 11, line 17:	delete "r^{*}_{t}" insert --$r_t^{i^*}$ --
Claim 18, Column 12, line 16:	delete "sub-carrier index" insert --sub-carrier index Z--
Claim 18, Column 12, line 25:	delete "$l \in [-N_{max}, N_{max}];$" insert --$k \in [-N_{max}, N_{max}];$--

Claim 18, Column 12, line 28:	delete "K_{min}"
	insert --k_{min}--
Claim 23, Column 12, line 56:	delete "synchronization"
	insert --synchronizing--
Claim 24, Column 13, line 20:	delete "$r^{*}{}_{t}$"
	insert --$r_t^{i^*}$--
Claim 28, Column 14, line 30:	delete "$l \in [-N_{\max}, N_{\max}];$"
	insert --$k \in [-N_{\max}, N_{\max}];$--
Claim 28, Column 14, line 33:	delete "K_{min}"
	insert --k_{min}--

Enclosed herewith is a copy of Applicants' November 23, 2004 Amendment After Notice of Allowance under 37 C.F.R. 1.312 for your reference. It is respectfully requested that a Certificate of Correction be issued to correct the aforementioned errors, or in the alternative that a corrected patent be issued. Enclosed herewith are two copies of a proposed Certificate of Correction indicating the errors and corrections thereof.

No new matter has been added.

The claims currently presented are proper and definite. Allowance is accordingly in order and respectfully requested. However, should the Examiner deem that further clarification of the record is in order, we invite a telephone call to the Applicants' undersigned attorney to expedite further processing of the application to allowance.

No additional fees are believed due in connection with this submission, however, the Director is hereby authorized to charge any fees due credit any overpayment of same, to Deposit Account No. 50-0311, Reference No. 27996-092, Customer No. 35437.

Dated: June 28, 2006

Respectfully submitted,

Boris A. Matvenko, Reg. No. 48,165
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Express Mail Label No.: EV 452427339 US
Date of Deposit: November 23, 2004

Attorney Docket No. 27996-092

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Appl. No.	:	09/751,881	Confirmation No.: 8544
Applicant	:	Jianglei Ma, *et al.*	
Assignee	:	Nortel Networks Limited	
Filed	:	December 29, 2000	
Examiner	:	Prenell P. Jones	
Art Unit	:	2667	
Docket No.	:	27996-092	
Title	:	SYNCHRONIZATION IN A MULTIPLE-INPUT/MULTIPLE-OUTPUT (MIMO) ORTHOGONAL FREQUENCY DIVISION MULTIPLEXING (OFDM) SYSTEM FOR WIRELESS APPLICATIONS	

Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

AMENDMENT AFTER NOTICE OF ALLOWANCE
UNDER 37 CFR §1.312

This paper is in response to the Notice of Allowance, mailed on August 24, 2004, in the above-identified patent application. The Commissioner is hereby authorized to charge any additional fees that may be due, or credit any overpayment of same, to Deposit Account No. 50-0311, Reference No. 27996-092, Customer No. 35437.

Please amend the above-identified application as follows:

Amendments to the Specification begin on page 2 of this paper.

Amendments to the Claims begin on page 3 of this paper.

Amendments to the Drawings begin on page 18 of this paper and include both an attached replacement sheet and an annotated sheet showing changes.

Remarks begin on page 19 of this paper.

Amendments to the Specification:

Please replace the paragraph beginning at page 10, lines 11-16 with the following paragraph:

--Figure 2 illustrates a block diagram of the logic used to perform the course synchronization. This can be performed by an application specific integrated circuit (ASIC), by a microprocessor, or some other processor. As illustrated in figure 2, the apparatus includes delay 10, multipliers 35, summers 40, absolute value squared 15, integral 20, summation 30 and maximum value selector 25. As illustrated, by the blank boxes <u>60 and 65</u>, the same circuitry or logic may be duplicated.--

Please replace the paragraph beginning at page 11, lines 1-10 with the following paragraph:

--The fine synchronization process (Figure 3) uses one or more preambles stored in a memory, and matches the stored preambles(s) to the transmitted preamble(s). From the starting point determined by the coarse synchronization and traversing forward and/or backward along the data stream, the encountered preambles are compared to the stored preamble by computing a correlation until a complete match is found. Figure 3 illustrates a block diagram of the logic employed to perform this fine synchronization. This too can be realized by an application specific integrated circuit (ASIC), by a microprocessor, or some other processor. As illustrated in figure 3, the apparatus includes even pn codes 50, odd pn codes 45 multipliers 35, integral 20, and maximum value selector 25. As illustrated, by the blank boxes <u>55</u>, the same circuitry or logic may be duplicated.

Amendments to the Claims:

This listing of claims will replace all prior versions, and listings, of claims in the application.

1. (Currently Amended) In a multiple-input/multiple-output (MIMO), orthogonal frequency division multiplexing (OFDM) system, a method of ~~synchronization~~ synchronizing a receiver to a signal, which includes at least one preamble, said method comprising:

receiving said signal at a receiver;

determining a first starting position by applying a sliding correlator algorithm to said received signal; and

subsequent to finding said first starting position, finding a second starting position by matching at least one stored preamble to said received signal.

2. (Original) The method according to Claim 1 wherein said sliding correlator is defined by the following relations:

$$\Lambda^i(x) = \left| \sum_{l=0}^{N_{symbol}-1} r^i_t(x+l) r^{i*}_t(x+N_{symbol}+l) \right| - \rho/2 \sum_{l=0}^{N_{symbol}-1} [| r^i_t(x+l)|^2 + | r^i_t(x+N_{symbol}+l|^2]$$

where

$\rho = \frac{SNR+1}{SNR}$;

$x_{coarse}{}^{i} = \arg\max(\Lambda^i(x)) \mid (\arg\max(\Lambda^i\ (x)) > le)$;

r^i_t is the received signals (from ith receiver antenna);

r^*_t is the conjugate of the received signal;

SNR is signal-to-noise ratio;

N_{sample} is the number of plurality of samples in one OFDM symbol; and,

le is a threshold value.

3. (Original) The method according to Claim 1 wherein said matching is performed using algorithms defined by the relations:

$$\Lambda_{o,i}(x) = |\sum_{l=0}^{\frac{N_{fft}}{2}} [r^{i}_{t}(x+l) + r_{t}(x + \tfrac{N_{fft}}{2} + l) + r_{t}(x + N_{symbol} + l) + r_{t}(x + N_{symbol} + \tfrac{N_{fft}}{2} + l)] | \, pn_{o}^{*}(l)$$

and

$$\Lambda_{e,i}(x) = |\sum_{l=0}^{\frac{N_{fft}}{2}} [r_{t}(x+l) - r_{t}(x + \tfrac{N_{fft}}{2} + l) + r_{t}(x + N_{symbol} + l) - r_{t}(x + N_{symbol} + \tfrac{N_{fft}}{2} + l)] | \, pn_{e}^{*}(l)$$

where

j=1 represents a first receiving antenna and j=2 represents a second receiving antenna;

$$pn_o = IFFT(PN_o);$$
$$pn_e = IFFT(PN_e);$$

$$\Lambda_2 = \Lambda_{o,1} \Lambda_{o,2} \Lambda_{e,1} \Lambda_{e,2};$$

$$x_{fine} = \arg\max(\Lambda_2(x));$$
$$x \in [x_{coarse} - N_{fine}, x_{coarse} + N_{fine}];$$

PN_o is a known Prime Number (PN) code used to modulate odd-indexed pilots;

PN_e is a known Prime Number (PN) code used to module even-indexed pilots;

N_{fft} is FFT size; and,

N_{fine} is a number of samples to be searched backwards and forwards around the starting position obtained from a prior synchronization.

4. (Original) The method according to Claim 1 wherein said matching at least one stored preamble to said received signal includes matching a plurality of stored preambles to said received signal.

5. (Original) The method according to Claim 1 wherein said receiver includes a plurality of receivers;

each of said plurality of receivers respectively receives said signal from a respective transmitter; and,

each of said plurality of receivers determines a respective first starting position by applying said sliding correlator algorithm to said received signal.

6. (Original) The method according to Claim 5 wherein:

said MIMO OFDM system includes a plurality of MIMO channels;

each of said MIMO channels has a plurality of sub-carrier channels; and,

each of said sub-carrier channels has identical sub-carrier spacing,

the method further comprising:

calculating a frequency offset for a multiple of the sub-carrier spacing for each of the plurality of MIMO channels;

calculating a frequency offset for a fraction of the sub-carrier spacing for each of the plurality of MIMO channels;

calculating a total frequency offset for each of said MIMO channels by summing said frequency offset for a multiple of the sub-carrier spacing for each MIMO channel with said frequency offset for a fraction of the sub-carrier spacing for each MIMO channel; and,

determining an average frequency offset for said plurality of MIMO channels by averaging the total frequency offset of each MIMO channel.

7. (Original) The method according to Claim 6 wherein said calculating a frequency offset for a multiple of the sub-carrier spacing for each of the plurality of MIMO channels further comprises calculating a shift of a pilot sub-carrier index for each preamble in the received signal.

8. (Original) The method according to Claim 7 wherein said calculating the shift of the pilot sub-carrier index is determined by the relations:

$$\Lambda_{i,j}(k) = \sum_{l=0}^{N_{tone}} R_{train}(k+l)PN^{*}{}_{i}(k_{\min}+l), \text{ where}$$

(i, j =1,2);

$l \in [-N_{\max}, N_{\max}]$;

$Z = \arg\max(\Lambda_{i,j}(k)) - k_{\min}$;

R_{train} is a received training symbol in frequency the domain;

K_{min} is an index of the first useful sub-carrier;

PN_i are known PN codes used by the transmitters; and

N_{max} is a value obtained from the expected maximum frequency offset.

9. (Original) The method according to Claim 6 wherein said calculating the frequency offset of a fraction of the sub-carrier spacing further comprises correlating two identical training symbols.

10. (Original) The method according to Claim 6 further comprising calculating a sampling clock offset by correlating two identical training symbols.

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11. (Original) The method according to Claim 6 wherein said determining the frequency offset of a fraction of the sub-carrier spacing for each of the plurality of MIMO channels includes calculating values of and a slope of a curve defined by the relation:

$$\Lambda\ (l) = angle(R_{train1}(l)R^{*}{}_{train2}(l));$$

where R_{train} represents training symbols.

12. (Original) The method according to Claim 10 wherein said calculating said sampling clock offset includes calculating a slope of a curve defined by the relation:

$$\Lambda\ (l) = angle(R_{train1}(l)R^{*}{}_{train2}(l)).$$

13. (Original) Apparatus for synchronization in a multiple-input/multiple-output (MIMO), orthogonal frequency division multiplexing (OFDM) system, a receiver to a received signal, said apparatus comprising:

storage means for storing at least one preamble;

receiver means coupled to said storage means, for receiving, a plurality of data frames, wherein each of said data frames includes at least one preamble and at least one symbol, and wherein said symbol includes a plurality of samples;

first synchronization means for applying a sliding correlator algorithm to said plurality of data frames; and,

second synchronization means for correlating a preamble in a data frame to said at least one preamble stored in said storage means.

14. (Original) The apparatus according to Claim 13 wherein said sliding correlator is defined by the following relations :

$$\Lambda^i(x) = \left|\sum_{l=0}^{N_{symbol}-1} r^i{}_t(x+l) r^{i*}{}_t(x+N_{symbol}+l)\right| - \rho/2 \sum_{l=0}^{N_{symbol}-1} [|r^i{}_t(x+l)|^2 + |r^i{}_t(x+N_{symbol}+l|^2]$$

;where

$\rho = \frac{SNR+1}{SNR}$;

$x_{coarse}{}^i = \arg\max(\Lambda^i(x)) \,|\, (\arg\max(\Lambda^i\ (x)) > le)$;

$r^i{}_t$ is the received signals (from ith receiver antenna);

$r^*{}_t$ is the conjugate of the received signal;

SNR is signal-to-noise ratio;

N_{sample} is the number of plurality of samples in one OFDM symbol; and

le is a threshold value.

15. (Original) The apparatus according to Claim 13 wherein said second synchronization means is configured to perform in accordance with the relations:

$$\Lambda_{o,i}(x) = \left|\sum_{l=0}^{\frac{N_{fft}}{2}} [r^i{}_t(x+l) + r_t(x+\tfrac{N_{fft}}{2}+l) + r_t(x+N_{symbol}+l) + r_t(x+N_{symbol}+\tfrac{N_{fft}}{2}+l)]\right| pn_o{}^*(l)$$

;and

$$\Lambda_{e,i}(x) = \left|\sum_{l=0}^{\frac{N_{fft}}{2}} [r_t(x+l) - r_t(x+\tfrac{N_{fft}}{2}+l) + r_t(x+N_{symbol}+l) - r_t(x+N_{symbol}+\tfrac{N_{fft}}{2}+l)]\right| pn_e{}^*(l)$$

;

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where

j=1 represents a first receiving antenna and j=2 represents a second receiving antenna;

$$pn_o = IFFT(PN_o)$$
$$pn_e = IFFT(PN_e);$$
$$\Lambda_2 = \Lambda_{o,1}\Lambda_{o,2}\Lambda_{e,1}\Lambda_{e,2};$$

$$x_{fine} = \arg\max(\Lambda_2(x));$$
$$x \in [x_{coarse} - N_{fine}, x_{coarse} + N_{fine}];$$

PN_o is a known Prime Number (PN) code used to modulate odd-indexed pilots;

PN_e is a known Prime Number (PN) code used to module even-indexed pilots;

N_{fine} is a number of samples to be searched backwards and forwards around the starting position obtained from a prior synchronization.

16. (Original) The apparatus according to Claim 13 wherein said preamble further includes at least one pilot sub-carrier having an index and at least one training symbol;

the system further including:

calculating means for calculating a frequency offset for a multiple of the sub-carrier spacing for each of the plurality of MIMO channels;

means for calculating a frequency offset for a fraction of the sub-carrier spacing for each of the plurality of MIMO channels;

summing means for calculating a total frequency offset for each of said MIMO channels by summing said frequency offset of a multiple of the sub-carrier spacing for each MIMO channel with the frequency offset of a fraction of the sub-carrier spacing for each MIMO channel; and

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averaging means for determining the average frequency offset for said plurality of MIMO channels by averaging the total frequency offsets of each MIMO channel.

17. (Original) The apparatus according to Claim 16 wherein said calculating means further comprises means for calculating a shift of the pilot sub-carrier index for each of the preambles in the plurality of data frames.

18. (Original) The apparatus according to Claim 17 wherein said means for calculating the shift of the pilot sub-carrier index for each of the preambles in the plurality of data frames is configured to operate in accordance with the relations:

$\Lambda_{i,j}(K) = \sum_{l=0}^{N_{tone}} R_{train}(k+l) PN^{*}{}_{i}(k_{\min}+l)$, where

(i, j =1,2);

$l \in [-N_{\max}, N_{\max}]$;

$Z = \arg\max(\Lambda_{i,j}(K)) - k_{\min}$;

R_{train} is a received training symbol;

K_{min} is an index of the first useful sub-carrier;

PN_i are known PN codes used by the transmitters; and

N_{max} is a value obtained from the expected maximum frequency offset.

19. (Original) The apparatus according to Claim 17 wherein said means for calculating the frequency offset of a fraction of the sub-carrier spacing for each of the plurality of MIMO channels further comprises means for correlating two identical training symbols.

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20. (Original) The apparatus according to Claim 16 further comprising means for calculating a sampling clock offset by correlating two identical training symbols.

21. (Original) The apparatus according to Claim 16 wherein said means for determining the frequency offset of a fraction of the sub-carrier spacing for each of the plurality of MIMO channels is configured to calculate values of and a slope of a curve defined by the relation:

$\Lambda\ (l) = angle(R_{train1}(l)R^{*}_{train2}(l))$, where

R_{train} represents training symbols.

22. (Original) The apparatus according to Claim 20 wherein said means for calculating said sampling clock offset is configured to calculate a slope of a curve defined by the relation:

$\Lambda\ (l) = angle(R_{train1}(l)R^{*}_{train2}(l))$.

23. (Original) Apparatus for synchronization, in a multiple-input/multiple-output (MIMO), orthogonal frequency division multiplexing (OFDM) system, a receiver to a received signal, said apparatus comprising:

a memory configured to store at least one preamble;

a receiver configured to receive a plurality of data frames ; wherein each of said frames includes at least one preamble and at least one symbol, said symbol including a plurality of samples;

a sliding correlator coupled to said receiver configured to apply a first synchronization

algorithm to said data frames; and

a correlating synchronizer for applying a second synchronization algorithm to said data frames by correlating a preamble in a single data frame to a preamble stored in said memory.

24. (Original) The apparatus of Claim 23 wherein said sliding correlator operates in accordance with the relations :

$$\Lambda^i(x) = \left|\sum_{l=0}^{N_{symbol}-1} r^i{}_t(x+l) r^{i*}{}_t(x+N_{symbol}+l)\right| - \rho/2 \sum_{l=0}^{N_{symbol}-1} [|r^i{}_t(x+l)|^2 + |r^i{}_t(x+N_{symbol}+l|^2]$$

;

where

$\rho = \frac{SNR+1}{SNR}$;

$x_{coarse}{}^i = \arg\max(\Lambda^i(x)) \mid (\arg\max(\Lambda^i\ (x)) > le)$;

r_t is the received signal;

r^*_t is the conjugate of the received signal;

SNR is signal-to-noise ratio;

N_{sample} is the number of plurality of samples in one OFDM symbol; and,

le is a threshold value.

25. (Original) The apparatus of Claim 21 wherein said correlating synchronizer is defined by the relations:

$$\Lambda_{o,i}(x) = \left|\sum_{l=0}^{\frac{N_{fft}}{2}} [r^i{}_t(x+l) + r_t(x+\tfrac{N_{fft}}{2}+l) + r_t(x+N_{symbol}+l) + r_t(x+N_{symbol}+\tfrac{N_{fft}}{2}+l)]\right| pn_o{}^*(l)$$

;

and

$$\Lambda_{e,i}(x) = \left| \sum_{l=0}^{\frac{N_{fft}}{2}} [r_t(x+l) - r_t(x + \tfrac{N_{fft}}{2} + l) + r_t(x + N_{symbol} + l) - r_t(x + N_{symbol} + \tfrac{N_{fft}}{2} + l)] \right| pn_e^*(l)$$

;

where

j=1 represents a first receiving antenna and j=2 represents a second receiving antenna;

$$pn_o = IFFT(PN_o);$$
$$pn_e = IFFT(PN_e);$$

$$\Lambda_2 = \Lambda_{o,1}\Lambda_{o,2}\Lambda_{e,1}\Lambda_{e,2};$$

$$x_{fine} = \arg\max(\Lambda_2(x));$$
$$x \in [x_{coarse} - N_{fine}, x_{coarse} + N_{fine}];$$

PN_o is a known Prime Number (PN) code used to modulate odd-indexed pilots;

PN_e is a known Prime Number (PN) code used to module even-indexed pilots; and,

N_{fine} is a number of samples to be searched backwards and forwards around the starting position obtained from a prior synchronization.

26. (Original) The apparatus according to Claim 23 wherein

said MIMO OFDM system includes a plurality of MIMO channels;

each of said MIMO channels has a plurality of sub-carrier channels; and,

each of said sub-carrier channels has identical sub-carrier spacing,

the apparatus further comprising:

a processor configured to calculate a frequency offset for a multiple of the sub-carrier spacing for each of the plurality of MIMO channels;

said process further configured to calculate a frequency offset for a fraction of the sub-carrier spacing for each of the plurality of MIMO channels;

said processor further configured to calculate a total frequency offset for each of said MIMO channels by summing said frequency offset for a multiple of the sub-carrier spacing for each MIMO channel with the frequency offset for a fraction of the sub-carrier spacing for each MIMO channel; and

said processor configured to determine an average frequency offset for said plurality of MIMO channels by averaging the total frequency offset of each MIMO channel.

27. (Original) The apparatus according to Claim 26 wherein said processor is configured to calculate a shift of the pilot sub-carrier index for each of the preambles in the plurality of data frames.

28. (Original) The apparatus according to Claim 26 wherein said processor is configured to apply said received signal to the relations:

$\Lambda_{i,j}(k) = \sum_{l=0}^{N_{tone}} R_{train}(k+l)PN^{*}_{i}(k_{\min}+l)$, where

(i, j =1,2);

$l \in [-N_{\max}, N_{\max}]$;

$Z = \arg\max(\Lambda_{i,j}(k)) - k_{\min}$;

R_{train} is a received training symbol;

K_{min} is an index of the first useful sub-carrier;

PN_i are known PN codes used by the transmitters; and

N_{max} is a value obtained from the expected maximum frequency offset.

29. (Original) The apparatus according to Claim 26 wherein said processor is configured to correlate two identical training symbols.

30. (Original) The apparatus of Claim 29 wherein said processor is configured to calculate a sampling clock offset by correlating said two identical training symbols.

31. (Original) The apparatus according to Claim 26 wherein said processor is configured to determine the frequency offset of a fraction of the sub-carrier spacing for each of the plurality of MIMO channels by calculating values of and a slope of a curve defined by the relation:

$\Lambda\ (l) = angle(R_{train1}(l)R^{*}{}_{train2}(l))$, where

R_{train} represents training symbols.

32. (Original) The apparatus according to Claim 30 wherein said processor is configured to calculate said sampling clock offset by calculating a slope of a curve defined by the relation:

$$\Lambda\ (l) = angle(R_{train1}(l)R^{*}{}_{train2}(l))$$

33. (Original) A method for synchronizing, in a multiple-input/multiple-output (MIMO), orthogonal frequency division multiplexing (OFDM) system, a receiver to a received signal, said method comprising:

receiving a plurality of data signals at a plurality of receivers over a plurality of MIMO

channels;

wherein each of said plurality of MIMO channels has a plurality of sub-carrier channels; and, each of said sub-carrier channels has identical sub-carrier spacing,

wherein said plurality of data signals each include at least one preamble and at least one symbol, and wherein said at least one symbol includes a plurality of samples;

separating at one of said plurality of receivers one of said plurality of signals from said plurality of signals

separating at another of said plurality of receivers another of said plurality of signals from said plurality of signals

respectively determining at said one of and said another of said plurality of receivers a starting position by applying a sliding correlator to the separated signals;

respectively determining at said one of and said another of said plurality of receivers another starting position by traversing said separated signals from said respective starting positions and comparing at least one stored preamble to said separated signals until said at least one stored preamble matches said separated signal in at least one of. said one of and said another of said plurality of receivers.

34. (Original) The method according to Claim 33 further comprising:

subsequent to matching said at least one stored preamble to said separated signal:

determining a frequency offset for a multiple of the sub-carrier spacing for each of the plurality of MIMO channels;

determining a frequency offset for a fraction of the sub-carrier spacing for each of the plurality of MIMO channels;

determining a total frequency offset for each of said MIMO channels by summing said frequency offset for a multiple of the sub-carrier spacing for each MIMO channel with said frequency offset for a fraction of the sub-carrier spacing for each MIMO channel; and,

determining an average frequency offset for said plurality of MIMO channels by averaging the total frequency offset of each MIMO channel.

Amendments to the Drawings:

The attached sheets of drawings include changes to Figure 2 and Figure 3. These sheets, which include Figure 2 and Figure 3 replace the original sheets of Figure 2 and Figure 3. In Figure 2, the applicant has labeled the two horizontal rectangular items at the bottom of the figure as 60 and 65. In Figure 3, the applicant has labeled the single horizontal rectangular item at the bottom of the figure as 55.

Attachments: (1) Replacement Sheets; and

(2) Annotated Sheets Showing Changes.

REMARKS

In the specification, page 10, lines 11-16 and page 11, lines 1-10 have been amended to refer to the labels in the amended drawings.

Figure 2 and Figure 3 have been amended to include the additional labels suggested by the Examiner.

Claim 1 has been amended to correct a typographical error.

CONCLUSION

Applicants respectfully request entry of the above amendments. If there are any questions regarding these amendments and remarks, the Examiner is encouraged to contact the undersigned at the telephone number provided below.

Date: November 23, 2004

Respectfully submitted,

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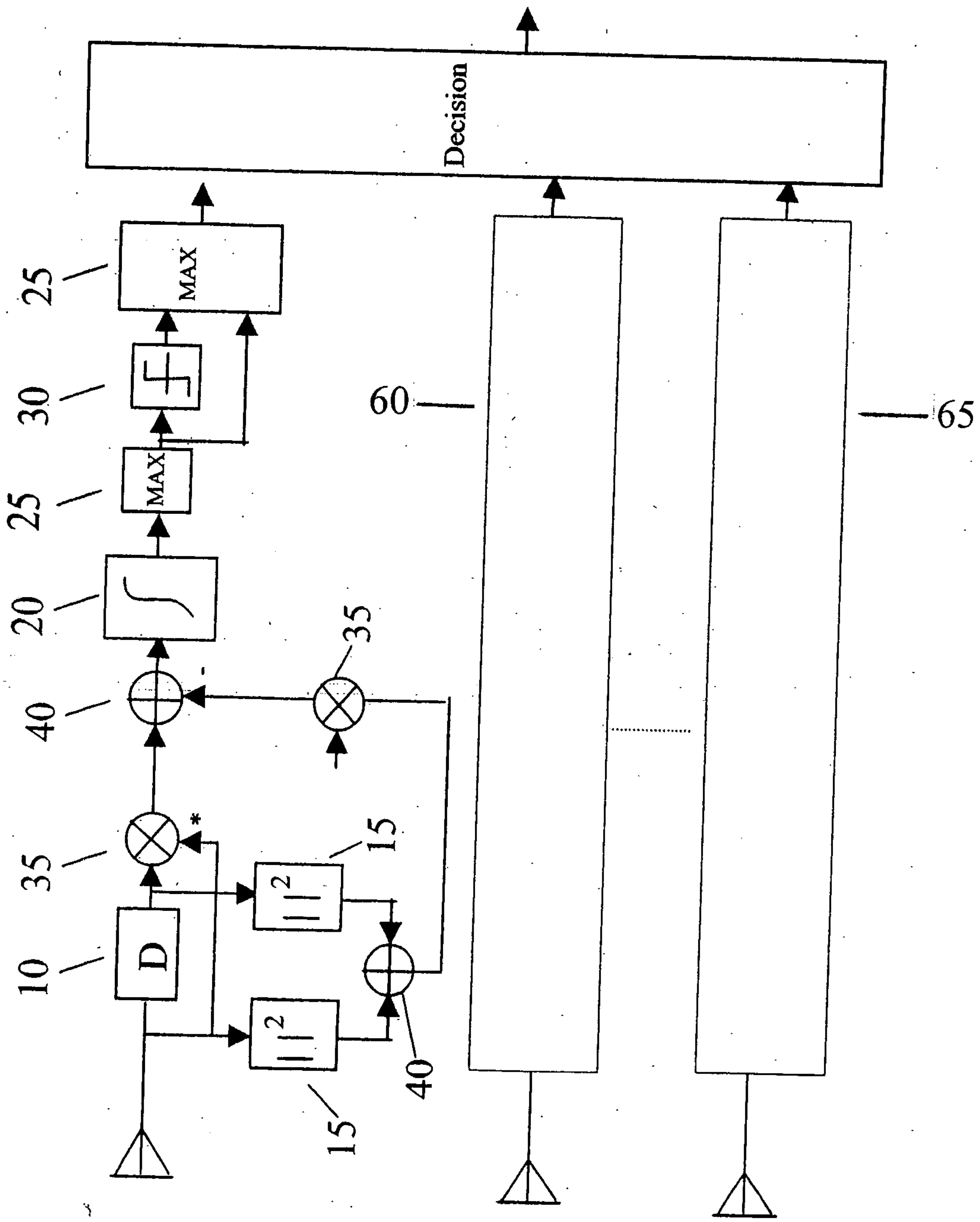

Figure 2

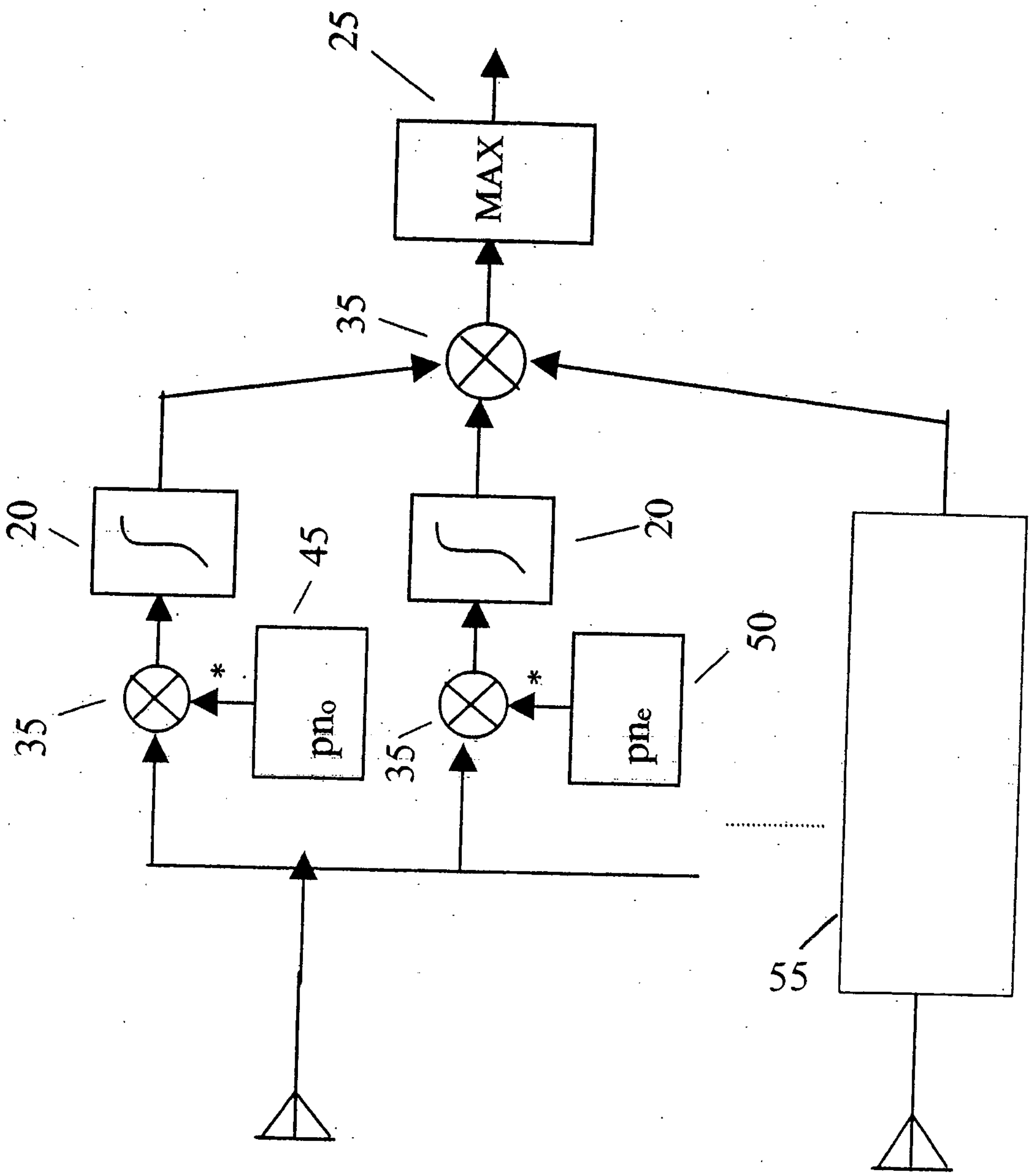

Figure 3

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Attorney Docket No. 27996-092

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO.: 7,009,931
DATED: March 7, 2006
INVENTORS: Jianglei Ma, *et al.*

It is certified that the related application data listed below have been omitted in the above-identified Letters Patent. The Letters Patent is hereby corrected as shown below:

In the Summary of Invention:

Column 2, line 33: delete "synchronization"
insert --synchronizing--

Column 3, line 10: delete "course"
insert --coarse--

In the Detailed Description of the Invention:

Column 7, line 54: delete "$k\,\mathrm{min}$"
insert --$k_{\min}$--

Column 7, line 57: insert --$l \in [-N_{\max}, N_{\min}], and$--

Column 7, line 57: delete "$l \in [-N_{\max}, N_{\min}], and$"
insert --$k \in [-N_{\max}, N_{\min}], and$--

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NYC 364637v.1

UNITED STATES PATENT AND TRADEMARK OFFICE

CERTIFICATE OF CORRECTION

PATENT NO.: 7,009,931
DATED: March 7, 2006
INVENTORS: Jianglei Ma, *et al.*

It is certified that the related application data listed below have been omitted in the above-identified Letters Patent. The Letters Patent is hereby corrected as shown below:

In the Claims:

Claim 1, Column 8, line 48: delete "received signal; and"

Claim 1, Column 8, line 42: delete "synchronization"
insert --synchronizing--

Claim 1, Column 8, line 47: insert --received signal; and-- after words "correlator algorithm to said"

Claim 2, Column 8, line 56: delete "$\rho/2$"

Claim 2, Column 8, line 59: insert -- $\rho/2$ -- in front of the words "$\sum_{l=0}^{N_{symbol}-1}$"

Claim 2, Column 8, line 65: delete "X_{coarse}^{i}"
insert -- x_{coarse}^{i} --

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Express Mail Label No.: EV829090208US
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CERTIFICATE OF CORRECTION

PATENT NO.: 7,009,931
DATED: March 7, 2006
INVENTORS: Jianglei Ma, *et al.*

It is certified that the related application data listed below have been omitted in the above-identified Letters Patent. The Letters Patent is hereby corrected as shown below:

In the Claims (cont.):

Claim 2, Column 8, line 67: delete "$r^{*}{}_{t}$"

insert -- $r_t^{i^*}$ --

Claim 3, Column 9, line 34: delete "X_{fine}"

insert -- x_{fine} --

Claim 3, Column 9, line 35: delete "$X \in [X_{coarse} - N_{fine}, X_{coarse} + N_{fine}];$"

insert -- $x \in [x_{coarse} - N_{fine}, x_{coarse} + N_{fine}];$ --

Claim 8, Column 10, line 14: delete "index is determined"

insert --index Z is determined

Claim 8, Column 10, line 23: delete "$l \in [-N_{\max}, N_{\max}];$"

insert -- $k \in [-N_{\max}, N_{\max}];$ --

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CERTIFICATE OF CORRECTION

PATENT NO.: 7,009,931
DATED: March 7, 2006
INVENTORS: Jianglei Ma, *et al.*

It is certified that the related application data listed below have been omitted in the above-identified Letters Patent. The Letters Patent is hereby corrected as shown below:

In the Claims (cont.):

Claim 8, Column 10, line 26:	delete "frequency the" insert --the frequency--
Claim 8, Column 10, line 28:	delete "K_{min}" insert --k_{min}--
Claim 13, Column 10, line 53:	delete "synchronization" insert --synchronizing--
Claim 14, Column 11, line 5:	delete "$\rho/2$"
Claim 14, Column 11, line 8:	insert --$\rho/2$-- in front of the words "$\sum_{l=0}^{N_{symbol}-1}$"

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PATENT NO.: 7,009,931
DATED: March 7, 2006
INVENTORS: Jianglei Ma, *et al.*

It is certified that the related application data listed below have been omitted in the above-identified Letters Patent. The Letters Patent is hereby corrected as shown below:

In the Claims (cont.):

Claim 14, Column 11, line 15: delete "X_{coarse}^{i}"

insert -- x_{coarse}^{i} --

Claim 14, Column 11, line 17: delete "r^{*}_{t}"

insert -- $r_t^{i^*}$ --

Claim 15, Column 11, line 49: delete "X_{fine}"

insert -- x_{fine} --

Claim 15, Column 11, line 50: delete "$X \in [X_{coarse} - N_{fine}, X_{coarse} + N_{fine}];$"

insert -- $x \in [x_{coarse} - N_{fine}, x_{coarse} + N_{fine}];$ --

Claim 18, Column 12, line 16: delete "sub-carrier index"

insert --sub-carrier index Z--

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DATED: March 7, 2006
INVENTORS: Jianglei Ma, *et al.*

It is certified that the related application data listed below have been omitted in the above-identified Letters Patent. The Letters Patent is hereby corrected as shown below:

In the Claims (cont.):

Claim 18, Column 12, line 21: delete "PN_l^*"

insert -- PN_i^* --

Claim 18, Column 12, line 25: delete "$l \in [-N_{max}, N_{max}];$"

insert -- $k \in [-N_{max}, N_{max}];$ --

Claim 18, Column 12, line 28: delete "K_{min}"

insert --k_{min}--

Claim 23, Column 12, line 56: delete "synchronization"

insert --synchronizing--

Claim 24, Column 13, line 18: delete "$X_{coarse}{}^i$"

insert -- $x_{coarse}{}^i$ --

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DATED: March 7, 2006
INVENTORS: Jianglei Ma, *et al.*

It is certified that the related application data listed below have been omitted in the above-identified Letters Patent. The Letters Patent is hereby corrected as shown below:

In the Claims (cont.):

Claim 24, Column 13, line 20: delete "r^{*}_{t}"

insert -- $r_t^{i^*}$ --

Claim 25, Column 13, line 51: delete "X_{fine}"

insert -- x_{fine} --

Claim 25, Column 13, line 52: delete "$X \in [X_{coarse} - N_{fine}, X_{coarse} + N_{fine}];$"

insert -- $x \in [x_{coarse} - N_{fine}, x_{coarse} + N_{fine}];$ --

Claim 28, Column 14, line 27: delete "$R_{train\int_{\square}^{\square} d\square}$"

insert -- R_{train} --

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DATED: March 7, 2006
INVENTORS: Jianglei Ma, *et al.*

It is certified that the related application data listed below have been omitted in the above-identified Letters Patent. The Letters Patent is hereby corrected as shown below:

In the Claims (cont.):

Claim 28, Column 14, line 30: delete "$l \in [-N_{max}, N_{max}];$"

insert --$k \in [-N_{max}, N_{max}];$--

Claim 28, Column 14, line 33: delete "K_{min}"

insert --k_{min}--

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